Balakrishnan
Handout #13
Sep 30, 1998

EE301 Midterm #1

1. Enter your name, student ID number, e-mail address and your full signature in the space provided on this page.
2. You have **fifty minutes**.
3. There are **10** pages in the exam booklet. Use the back of each page for rough work, if necessary.
4. You are **not** allowed the use of crib sheets.
5. You are **not** allowed the use of calculators.
6. Tip: Make sure you read through the exam once before beginning. Work as quickly and efficiently as you can. If you get stuck on a certain problem, move on to others.
7. **Unless otherwise instructed, no justification is necessary.**
8. **Unless otherwise stated, no partial credit will be given, therefore work as carefully as you can.**
9. **Enter your answers in the spaces provided.**

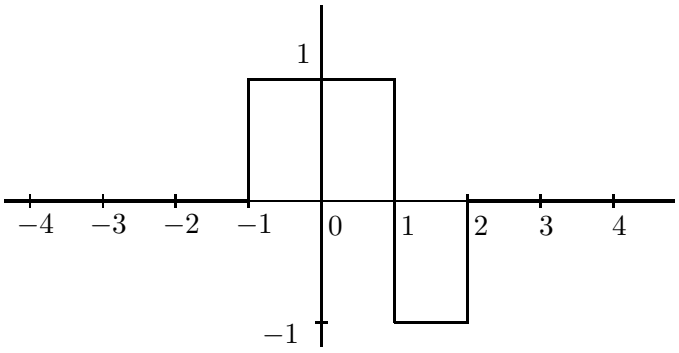
Name:
Student ID #:
E-mail address:
Signature:

1. (30 pts)

A continuous-time signal $x(t)$ is defined by

$$x(t) = \begin{cases} 0, & -\infty < t \leq -1, \\ 1, & -1 < t \leq 1, \\ -1, & 1 < t \leq 2, \\ 0, & 2 < t < \infty. \end{cases}$$

A sketch of $x(t)$ is shown below.



- A number of questions based on this signal are given on the next page. Answer them, making sure to enter your answers in the spaces provided on the next page. **Failure to do so may result in your getting zero credit.** Use the space below and the back of this page for any rough work.
- **No partial credit will be given for any part of this problem, therefore work as carefully as you can.**
- **No justification is necessary.**

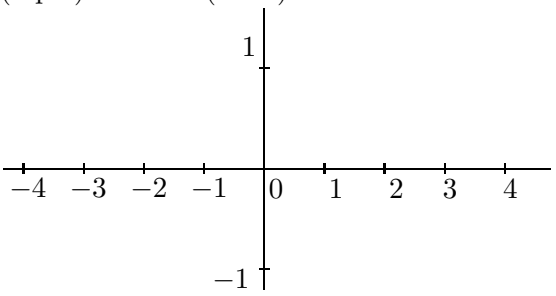
(a) (3 pts) Calculate E_∞ for $x(t)$, i.e., the energy of $x(t)$ over the interval $(-\infty, \infty)$.

$E_\infty =$

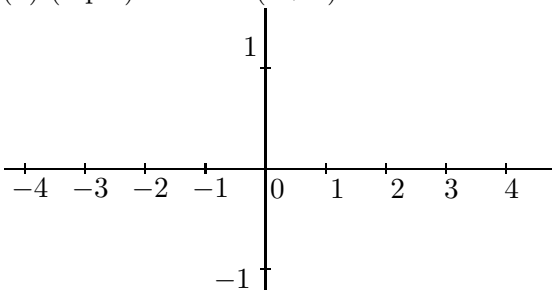
(b) (3 pts) Calculate P_∞ for $x(t)$, i.e., the power of $x(t)$ over the interval $(-\infty, \infty)$.

$P_\infty =$

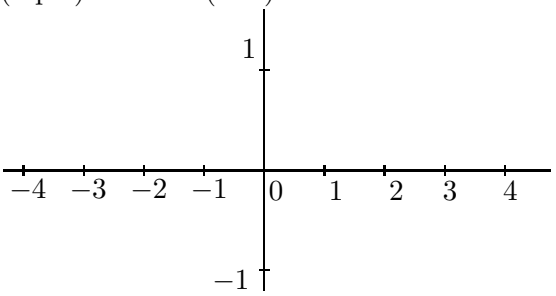
(c) (2 pts) Sketch $x(t-1)$ below.



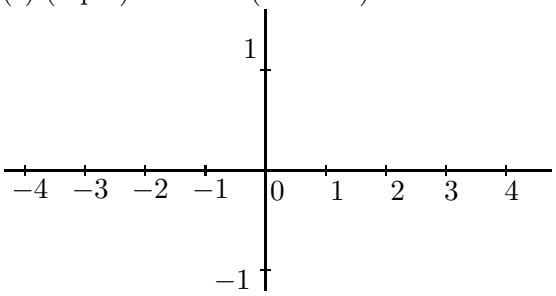
(d) (2 pts) Sketch $x(t+1)$ below.



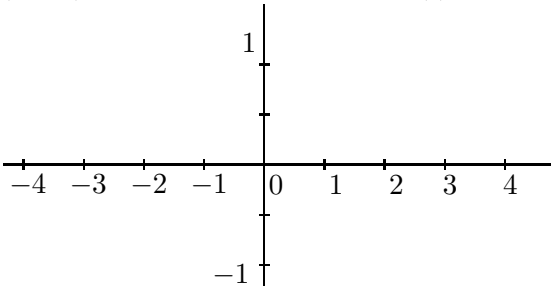
(e) (5 pts) Sketch $x(0.5t)$ below.



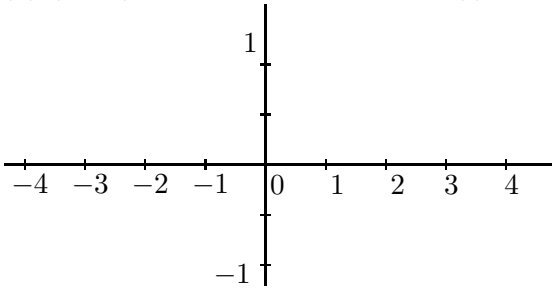
(f) (5 pts) Sketch $x(1-0.5t)$ below.



(g) (5 pts) Sketch the even part of $x(t)$ below.



(h) (5 pts) Sketch the odd part of $x(t)$ below.



2. (20 pts) Classify the following signals as periodic or Non-periodic; for periodic signals, calculate the fundamental period. Enter your answers in the spaces provided.

   - **No partial credit will be given for any part of this problem, therefore work as carefully as you can.**
   - **No justification is necessary.**

   (a) (4 pts) $x(t) = \sin(4t + \pi/8)$.

   ☐ Non-periodic

   ☐ Periodic; Period = ____

   (b) (4 pts) $x(t) = \sin t + \sin(2t + \pi/8)$.

   ☐ Non-periodic

   ☐ Periodic; Period = ____

   (c) (4 pts) $x[n] = e^{j\pi n/8}$.

   ☐ Non-periodic

   ☐ Periodic; Period = ____

   (d) (4 pts) $x[n] = 2^{-n}e^{j\pi n/8}$.

   ☐ Non-periodic

   ☐ Periodic; Period = ____

   (e) (4 pts) $x[n] = e^{jn/8}$.

   ☐ Non-periodic

   ☐ Periodic; Period = ____

3. (10 pts) Determine if the following systems (with input x and output y) are linear or nonlinear; time-invariant or time-varying; memoryless or with-memory; causal or non-causal; stable or unstable.

   - **No partial credit will be given for any part of this problem, therefore work as carefully as you can.**
   - **No justification is necessary.**

   (a) (5 points) $y(t) = \dfrac{d}{dt}(x(t))$.

   ☐ Linear ☐ Nonlinear

   ☐ Time-invariant ☐ Time-varying

   ☐ Memoryless ☐ With-memory

   ☐ Causal ☐ Noncausal

   ☐ Stable ☐ Unstable

   (b) (5 points) $y[n] = \begin{cases} 0 & n < 0, \\ \displaystyle\sum_{0}^{n} x(n) & n \geq 0. \end{cases}$

   ☐ Linear ☐ Nonlinear

   ☐ Time-invariant ☐ Time-varying

   ☐ Memoryless ☐ With-memory

   ☐ Causal ☐ Noncausal

   ☐ Stable ☐ Unstable

4. (20 points) Let the impulse response $h(t)$ of a continuous-time LTI system be

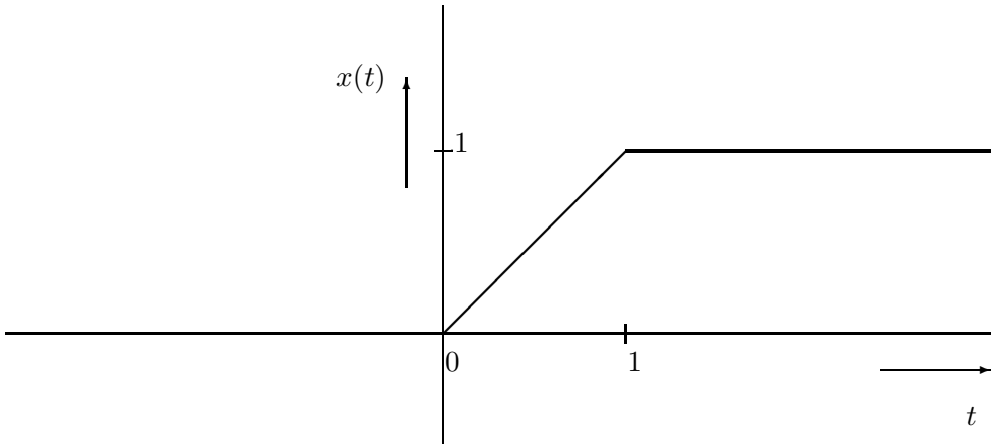
$$h(t) = \begin{cases} 0 & t < 0, \\ 1 & t \geq 0. \end{cases}$$

Thus, the impulse response is simply the unit step function.

For this system, suppose the input signal is

$$x(t) = \begin{cases} 0 & -\infty < t \leq 0, \\ t & 0 < t \leq 1, \\ 1 & 1 < t \leq \infty. \end{cases}$$

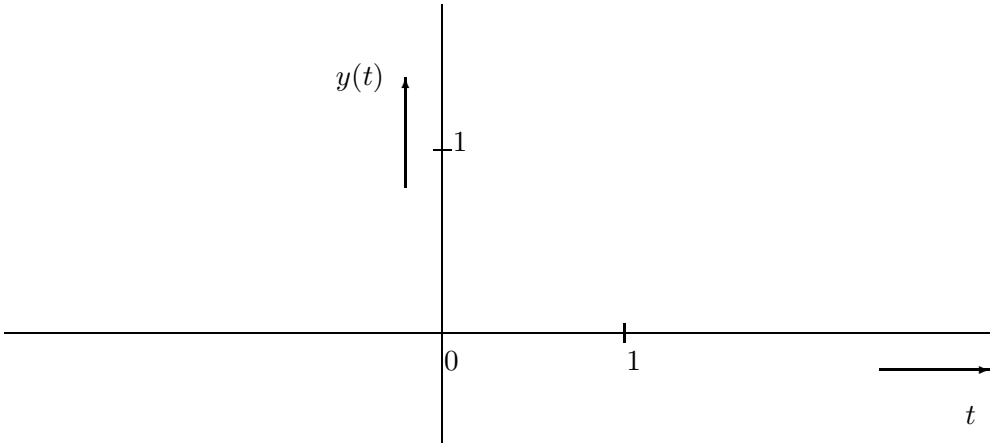
A sketch of $x(t)$ is shown below:



Find the output $y(t)$, and sketch it on the graph provided on the next page.

- **You must show all the work you did in determining $y(t)$.** Merely writing down your answer with no justification will likely earn you zero credit.
- Work as neatly as you can.
- Use the back of this page, if you need extra space.

Sketch the output $y(t)$ of the system here.



5. (20 points)

For all parts of this problem:

- **You must show all the work you did in obtaining your answers.** Merely writing down your answers with no justification will likely earn you zero credit.
- Work as neatly as you can.

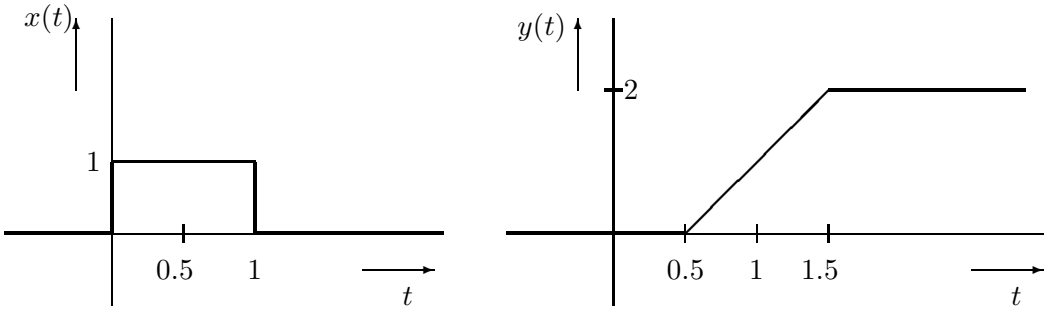
The output $y(t)$ of a causal LTI system corresponding to the input

$$x(t) = \begin{cases} 0 & -\infty < t \leq 0, \\ 1 & 0 < t \leq 1, \\ 0 & 1 < t < \infty. \end{cases}$$

is

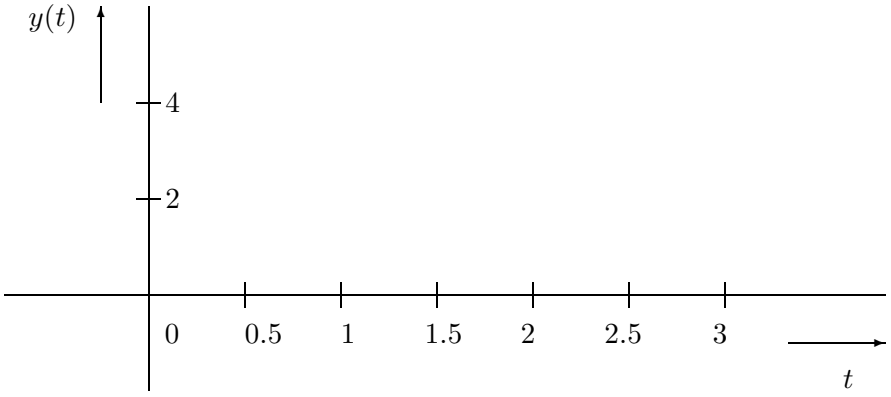
$$y(t) = \begin{cases} 0 & -\infty < t \leq 0.5, \\ 2(t-0.5) & 0.5 < t \leq 1.5, \\ 2 & 1.5 < t < \infty. \end{cases}$$

A sketch of the input $x(t)$ and the output $y(t)$ are shown below:



(a) (5 pts) Find the output of the system corresponding to the input $x(0.5t)$, and sketch it on the graph provided on the next page.

Sketch the output of the system corresponding to the input $x(0.5t)$ here.



(b) (15 pts) Find the impulse response of the system, and sketch it on the graph below.